Impact of Assurance of Learning (AOL) in Programming Course for Novices

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One of the aims of any higher education institution is to align its curriculum with program learning goals. Programs which ensure proper learning have positive effects on students, instructors, departments and also on the higher education institution itself. This paper discusses the implementation and effects of Assurance Of Learning (AOL) processes on introductory programming (IP) courses. It elaborates five stages of AOL to align program learning goals with IP curriculum. Then, it discusses how the AOL process identifies shortcomings in the assessment methods of IP courses. Furthermore, it enlightens how the assessment findings, as a result of the AOL process, provide mechanisms to address the drawbacks during the delivery of such courses. Feedback on the effectiveness of AOL programs on teaching and learning process was gathered from faculty.

Analyze Achievement Measure, Assurance of Learning, Course Objectives, Knowledge and Performance.

1. INTRODUCTION

Buraimi University College, Oman (BUC) has an academic affiliation with the California State University, Northridge, USA (CSUN). Both institutions commenced an Assurance of Learning (AOL) program as part of their annual agreement to improve academic quality. According to the agreement, CSUN provides a consultation service to implement the AOL program in all academic departments at BUC.

2. STEPS TOWARD ASSURANCE OF LEARNING

Assurance of Learning (AOL) provides a mechanism to align program learning goals with departmental learning goals (Kinash et al, 2012). The Association to Advance Collegiate Schools of Business (AACSB) defines the AOL process in five steps and, these are described in figure 1 (AACSB, 2007).

3. METHODOLOGY

Information Technology (IT) department at BUC implemented AOL on the course '030112: Introduction to programming and algorithm' which is one of the core subjects offered to Level-1 students. The assessment data of 95 students including 75 females and 20 males were analysed during the implementation of AOL for this course. Fifty-one faculty members from different departments, including I.T, English, Business and Foundation Units, participated in the web based survey to obtain the

faculty perspective of the impact of AOL in the learning process.

4. IMPLEMENTATION OF AOL IN CURRICULUM

The IT department at BUC took the following steps to implement the AOL program.

4.1 Define and Align Course Learning Goals with Program Learning Goals

The AOL standard recommends four to ten learning goals for each degree program. The department offers only Computer Science (C.S) and Information Systems (I.S) programs and its general and specific learning goals are revised to meet the AOL standards.

Figure 1: Assurance of Learning (A.O.L) steps

The objectives of the course '030112: Introduction to programming and algorithm' were revised and aligned

to program learning goals. Curriculum matrices were prepared to align the program learning goals of computer science and information systems with their core courses.

4.2 Instruments to Measure Learning

The assessment tools used in the course '030112: Introduction to programming and algorithm' includes tests, quizzes, assignment and final examination.

4.3 Analyse and Use Assessment Information for Continuous Improvement

The students' overall results were analyzed and a report was produced based on the assessment findings, which was then shared with the academic staff of the department. This procedure helped to drive program improvement by analyzing students' assessment data. Data mining was performed after collecting data from all assignments. Figure 2 shows the data (marks) accumulated from the assessment including 3 tests and a take-home assignment (T1, T2, T3 and A respectively) for all students in one section of the course. It also shows the accumulated data for different objectives measured through the various assignments.

satisfactory category. The students' performance in objectives 1, 3, and 4 is not satisfactory. Accumulated Students' performances of the various assessments from all the sections are represented both quantitatively and graphically. Figure 3 shows the summary from three different sections of the IP course.

The overall achievements of students in each objective for the selected sample course do not show a satisfactory result. This is one of the major problems faced in the Computer Science program; high failure rates are experienced in IP courses and, as a consequence, there is a very high dropout rate from the Computer Science program.

Table 1 shows the course parameters the course parameters related to assessment methods and teaching strategies used in the IP courses. It is clear that problem solving strategies covered in Objective 1 had been given less time compared to the other objectives. De Raadt, M. (2008) pointed out that poor performance of novice programmers is related to the teaching approach used in traditional introductory courses which fail to adequately teach programming knowledge and problem solving strategies to most of the students.

Figure 2: Assessment for assignments (Test1, Test2, Assignment, Test3) recorded for one section of a class

Figure 2 also shows the overall achievements of objectives. Only objective 2 result falls under

Table 1 shows that problem solving strategies are incorporated only in Objective 1. We have two suggestions. The first is to increase the dedicated teaching time for Objective 1. The second is to

Figure 3: Summary of Assessments with various assignments in different sections of classes

incorporate problem solving strategies throughout the course. De Raadt et al. (2005) examined 40 textbooks on IP courses and discovered that only a small proportion of these (6 out of 40) integrated problem solving strategies throughout the book. Robin et al (2003) discussed that “typical IP textbooks devote most of their content to presenting knowledge about a particular language”.

Figure 3 shows the overall assessment results of Test1, Test2 and Final Examination from all the three sections. The Test1 results show highest failure rate which is 46%. It assesses Objective 1 and 2. An informal interview was conducted with the instructor to discuss the test results. The instructor indicated that Test1 covered problem solving strategies and introductory features of C++ programming. The result was disappointing since this was students’ first exposure to programming languages. It was difficult for them to visualize the problem domain. This argument is supported by Deek et al (1998). They introduced a course based using a problem solving model for the first year of a Computer Science Major. The students were introduced to programming features in the context of specific problems. So we suggested incorporating problem solving strategies throughout the course to improve students’ performance.

The IP features such as variable declaration, input/output operations were also covered in Test1.

The instructor argued that it was difficult for students to understand memory allocation process for variable declaration and input/output operations. Ala-Mutka (2004) discussed that visualizations helped students in understanding basic concepts and structures. Table 1 shows that visuals/multimedia aides are not used in the teaching process. Therefore we recommend using effective visualizations in programming courses, particularly at the beginning, so that students can understand and visualize the connection between program structures and memory.

Test2 results shows better performance with 29% failure compared to 46% in Test1. It covers Objectives 3 and 4. The instructor pointed out that control statements were difficult for students to understand. On the other hand, they improved their ability to apply a programming mental model by practicing it. Winslow (1996) argued that practice is an important part in learning to program. Furthermore, designing practice questions for programming syntax is easy compared to designing problem solving questions. Therefore we suggested including Graded Lab sheets (exercises) as one of the components of the assessment strategy. On the other hand, Barros et al (2003) discussed practical oriented Lab Exams to ensure programming practice in IP courses instead of assignments. They argued that assignment-based assessment may lead students to an excessive dependency on group work or to fraudulent behavior (plagiarism and cheating). The Lab Exams achieved the objectives by forcing individual practice, increasing students’ motivation, and self-assessment opportunities (Barros et al,

2003). Table 1 show that Lab Exams and Graded Lab Exercises are not used in teaching process. We suggest incorporating both these methods as part of the assessment regime. It will promote individual practice and collaborative learning (Mathews et al, 2009) in the learning process.

The Final Examination results show better performance of students in comparison to Test1 and Test2. The examination covered questions from all four Objectives. The instructor argued that with the passage of time, students acquired better exposure to the problem domain and problem solving techniques. We asked the instructor to list three difficult topics for students to understand from the whole course. The instructor pointed out the topics related with control structures, arrays and loops. Pane and Myers (1996) mentioned that looping is a commonly difficult area for novices. Du Boulay (1989) noted that novices confused array subscripts with stored values.

Table 1: Analysis of course parameters

Objective Number	Main Topics	Assessment Methods	Teaching Strategies	Teaching Hrs	Inclusion of problem solving	No. of Exercises/Tutorials	No. of Assignments	No. of Lab Exams	No. of Graded Lab Sheets	Discuss Programs/flow charts	Show images/Diagram	No. of Multimedia / Visual Aides
1	Solution & software development Flowchart Pseudo code	Test1, Quizzes, Final Exam, Assignment	Lecture, Lab sheets	14%	✓	1	1	0	0	✓	✓	0
2	-Data types -I/O statement Operators Expression	Test1, Quizzes, Final Exam, Assignment	Lecture, Lab Sheets	26%	✗	3		0	0	✓	✓	0
3	Control structures	Test2, Quizzes, Final Exam, Assign.	Lecture, Lab Sheets	30%	✗	5		0	0	✓	✓	0
4	Functions Arrays	Test2, Quizzes, Final Exam, Assign.	Lecture, Lab Sheets	30%	✗	5		0	0	✓	✓	0

The instructor pointed out to increase the credit hours (from 3 contact hours to 4) or reduce the syllabi of the courses for Programming 1 & 2 to make it more achievable in the light of students' actual outcomes. This point can be raised in a summary report of AOL assessment findings so that courses can be improved on the basis of students' assessment data. Schulte and Bennedsen (2006) also conducted a debate on restructuring IP course (CS1). According to them "explore what teachers believe is important to teach, what they actually teach, and what students find most difficult (according to their teachers)".

Table 1 show that one assignment was given to the students which covered all the four Objectives. The assessment methods were based on Test1, Test2 and Final exams. Winslow (1996) mentioned that "the old saw that practice makes perfect has solid psychological basis". The current assessment strategies don't adequately promote practice. Therefore we suggest increasing the number of assignments or incorporating graded lab exercises or

lab exams to do so.

Prasad and Li (2004) conducted a study with Information Systems and Computing majors' students of IP courses. This scenario is similar to our study because we also apply AOL model on students of Information Systems and Computing major. They discovered three areas of difficulties as arrays, functions and structure diagrams. It is different in our case (control structures, arrays and loops) because it also depends on topics covered in IP courses and on the time dedicated to teach each topic.

Winslow (1996) mentioned that a good pedagogy requires initial programming languages facts, models and rules to be simple at the beginning and increase complexity as the students gain experience. We asked the instructor about course syllabus and credit hours.

Al Nuaim et al (2011) mentioned that students' lack of English language abilities in the Gulf region is one of the reasons for poor understanding of programming language concepts. So instructors should incorporate different learning styles in their teaching process. Zander et al (2009) concluded that students of programming courses prefer active, sensing and visual learning styles. Therefore pair programming, Multimedia Learning Objects, Collaborative learning and visualization tools can be used to overcome the lack of English language capabilities and related problems. Recorded lectures can also be used to assist student learning. On the other hand, it may have adverse effects on class attendance.

4.4 Implementation

The recommendations given, as a result of 'Analysis & Reports' steps of AOL, are incorporated in the IP course. It mainly emphasized the addition of more problem solving strategies, visualizations, practice, lab exams, support of different learning styles and graded lab sheets. As outcome of implementing these strategies is a 10% improvement in students' results.

5. FACULTY FEEDBACK ON AOL PROGRAM

The results of the web based survey are presented in the Table 2 below which shows that an overwhelming majority of participants agreed and realized that AOL affected their training process in a positive way. Eight questions were asked during the online survey regarding the implementation of the AOL model for organizing, measuring, analysing students' knowledge and performance. The survey questions are:

The implementation of the AOL model:

- Q1. makes a significant effect on Teachers' performance in producing successful results from students.
- Q2. works better than the previously existing system.
- Q3. helps to improve effective delivery of various courses by teachers
- Q4. makes a significant effect on learning process.
- Q5. helps to analyze hidden data about the performance of a student in a course.
- Q6. helps to take effective actions after comparing the distribution of different levels of achievements with several assignments and sections of students taught by the same instructor.
- Q7. helps to improve effective satisfaction of teachers who are teaching various courses.
- Q8. Data, information and knowledge availability in the implementation of the model makes a significant difference in analyzing the effective Instructor performance.

Table 2: Survey: Faculty responses on the impact of AOL

Questions	No of Participants	Strongly disagree		Disagree		Neutral		Agree		Strongly Agree		N/A	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Q1	51	2	4	2	4	5	10	24	47	18	35	0	0
Q2	51	2	4	2	4	9	18	24	47	14	27	0	0
Q3	51	2	4	1	2	4	8	28	55	15	29	2	4
Q4	51	1	2	2	4	8	16	23	45	16	31	1	2
Q5	51	2	4	2	4	10	20	22	43	13	25	2	4
Q6	51	2	4	1	2	4	8	25	49	19	37	0	0
Q7	51	0	0	2	4	10	20	22	43	16	31	1	2
Q8	51	1	2	5	10	10	20	23	45	11	22	1	2
Average %		3%		4%		15%		47%		30%		2%	

6. CONCLUSION

The AOL provides a systematic process to revise and

align programs' learning goals, curriculum and assessment tools.

Students' knowledge is measured and their performance is analysed after organizing the objectives of the courses and aligning the assignments with each of the objectives for each course of the program. Teachers' performance in a department is also reflected and hence the performance of the whole department itself becomes very much evident. Based on the new information received, future actions can be planned and other appropriate decisions can be taken for improvement of the higher education institution itself.

The assessment data collected after AOL implementation on IP course helped us in highlighting weak areas in teaching programming concepts to novices. The data was analyzed and suggestions were incorporated to improve teaching and learning process.

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